Course Syllabus - CE 180

Engineering Systems

The Engineers of the 21st Century

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Readers: *Engineering Systems*, Part 1 - Course Readings
Part 2 - Lecture Illustrations and Notes, by Robert Bea
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Course description

Two reports have been published that summarize extensive studies of what will be the expectations of our next generation of engineers: The Engineer of 2020 and The Engineer of the 21st Century. One study addresses these expectations from the standpoint of the profession of engineering in a global context (National Academy of Engineering, 2004). The other study addresses the expectations from the standpoint of the profession of Civil Engineering in a national context (American Society of Civil Engineers, 2004). Both of these studies stress the need to add important elements to the education of engineers including Engineering Systems, Leadership, Management, Team-work in Interdisciplinary Teams, Learning from Successes and Failures, and Communications.

The capstone course, Engineering Systems (CE 180) has been specifically designed to address these expectations. The course includes segments on engineering leadership and management, teamwork and team development, communications, characterization and analyses of engineered systems, analyses of engineering successes and failures, the engineering Standard of Care, constraints and trade-offs in engineering, life-cycle engineering, quality and reliability assessments, human and organizational factors, and approaches to achieve desirable quality and reliability in engineering societal infrastructure systems.

Students form into interdisciplinary teams and address real-life projects that require exercise of their technical backgrounds and the additional elements developed in this and their other associated courses (e.g. humanities, history, art, and social studies). **The student teams work with professors from all of the groups in CEE and other UCB departments, experienced engineers and consultants to develop Civilization & Environmental Systems Engineering projects** including a project technical paper (and associated back-up documentation), a physical model of their system (or important parts), and at the end of the semester, present their projects to a panel of judges in a formal competition.

More information on and background for this course can be found at the course web site:
https://bspace.berkeley.edu/

Course conduct

Lectures for this course are scheduled for Tuesdays and Thursdays from 12:30 to 2:00 PM in 534 Davis Hall. The discussion section for this course is scheduled for Wednesdays from 2:00 to 3:00 PM in 544 Davis Hall. **All students are expected to attend both the course lectures and the discussion section (4 unit course).**

The lectures will start promptly at 12:40 PM and conclude promptly at 2:00 PM. Students are expected to be seated and prepared for the lectures before 12:40 PM. Normally, videos will be shown during the period between the conclusion of the preceding class and this class. These videos will have direct application to the lectures and contents of this course. The discussion section will start promptly at 2:10 PM and conclude promptly at 3:00 PM. Students are expected to be seated and prepared for the discussions before 2:00 PM.

The lectures will be based on PowerPoint presentations. The course reader has a copy of each of the lecture slides (2 per page) with a blank facing page. This blank facing page is for students to take notes during the lectures. PowerPoint slides will be used to summarize important points about each topic. Details on these topics will be developed during the lectures that are not included on the slides. Background and references on the majority of these topics are provided in the course reader. Sometimes, special slides and / or handouts will be provided during class to develop special points on timely topics or developments regarding the performance of engineered systems.

It is the responsibility of the student to do the required readings BEFORE the lectures. It is the responsibility of the student to take good and detailed notes DURING these lectures. In this way, the tendency to become entertained by the slides and think that the slides contain the important details can be avoided. Doing the assigned reading before the lectures helps students develop the necessary background to understand the details developed during the lectures. Important questions developed during the student preparation reading and note taking can provide the basis for listening during the lectures (to get answers to those questions) or posing those questions before or during the lectures so that the necessary understanding is developed.

The lectures will cover key topics associated with the focus of this course: **Engineering Systems**. The discussion section will cover associated key topics that are focused on the student team projects (e.g. selecting team projects, team development, developing and presenting successful projects). **All of the lectures and discussions have content that applies directly to the student team projects. The content of the student team projects are expected to reflect -- include these contents (applications of the course materials).**

There will be assignments associated with each of the lectures (individual and team) and discussion section for each week. The individual assignments associated with the lectures will be a written summary of the important points from the lectures and readings. These individual assignments will be compiled by each student to form parts of a course notebook that will be turned in for assessment at the end of the semester.

The team assignments associated with the lectures generally will be a written summary of how the lectures and readings apply to the team projects. These assignments will be incorporated into each of the team project notebooks.

The individual and team assignments associated with the lectures will be due on the Wednesday following the week in which the lectures were given (2:10 PM in box at front of class). The discussion section assignments will be developed on a week by week basis.

Schedule of readings and lectures

Week	Module	Content
1	Introduction	Course objectives, content, and conduct, grading, discussion section schedule, instructor and GSI backgrounds, student backgrounds & interests, the Engineer of 2020 (National Academy of Engineers) and the Engineer of the 21st Century (American Society of Civil Engineers Body of Knowledge)
2	Term Projects and Project Team Developments	Term project objectives, past project topics, how to define and re-define topics, topic attributes, formation and management of teams, advisors and consultants, winning projects. Formation of project teams, project team member characteristics, team management
3	Leadership and Management in Engineering Systems	Engineering, Leadership, Management. Planning, organizing, leading, and controlling to achieve quality and reliability in engineered systems
4	Leadership & Team Work in Engineering Systems	Processes and philosophies to develop cohesive, effective, and efficient engineering teams and leading engineering teams to be able to develop systems to achieve desirable quality & reliability
5	Failures of Engineered Systems and the Standard of Care in Engineering	Important factors and elements involved in past failures of engineered systems. The dividing line between acceptable and unacceptable engineering errors (malfunctions) made in development of engineered systems is defined as the Standard of Care (SOC)
6	Engineered Systems and System Analyses	Definition of engineered systems, what is different?, why an improvement?, synthesis and decomposition approaches, analytical modeling
7	**Team Projects**	**Report and presentation by each team summarizing the goals, objectives, organization, planning, and status of their projects**
8, 9	Life-Cycle System Engineering	Concept development, design, construction (manufacturing), operation, maintenance, and decommissioning - engineering roles and functions, critical constraints in the engineering processes
10	Objectives: Quality & Reliability	Definition of quality - the critical attributes of engineered systems. Definition of reliability - the assessment of likelihoods of achieving adequate quality during the life-cycle.
11	Engineering & Analyzing Systems: Reliability Based Criteria	Characterization of Engineered Systems. Analysis of systems composed of parallel and series elements. Development of Reliability Based Criteria for design of structural systems. Reliability based design criteria for different design formats (working stress, load and resistance factor, limit state). **Undergraduate Research Opportunity Poster Session for Projects.**
12, 13	Trade-offs, Economics, and Decision Analyses	Characterization of the important attributes of engineered systems, economics considerations that address income - cost - profitability assessments, decision analyses to define the system engineering options that can best develop desirable quality and reliability
14, 15	Approaches & Strategies to Achieve Adequate Quality & Reliability	Proactive (done before activities), reactive (done after activities), and interactive (done during activities) approaches. Reduce likelihoods, reduce consequences, and increase detection & correction strategies employed in the three approaches. Rehearsals for final presentations May 9, 3:30-5:00 pm, Sibley Auditorium.
16	**Presentation of Projects**	**Formal presentation of term project results including the project paper and a demonstration physical model of the system, Wednesday, May 14 8:30 am to 12:00 noon, Sibley Auditorium.**

Schedule of lecture assignments

Week	Module	Assignments
1	Introduction	Read Week 1 lecture notes. Read **"Teaching Engineering as a Social Science."** Read excerpts from the National Academy of Engineering ***Engineer of 2020*** and from the ASCE **Body of Knowledge - The Engineer of the 21st Century**. Summarize important points from Lectures and reading (each student). Summarize potential student team project proposals (due beginning Week 2).
2	Term Projects and Project Team Developments	Read Week 2 lecture notes. Read excerpts from **"Toward Effective Engineering Project Team Performance", "Team Performance Model" ,** and **"Behavioral Styles."** Summarize important points from Lectures and reading (each student).
3	Leadership and Management in Engineering Systems	Read Week 3 lecture notes. Read excerpts from ***Managing and Leading***. Read **"How Teams and Companies Win"** and **"Fast, High Quality Decisions and Results."** Read **"Why Professionals Can't Lead and What To Do About It"/** Summarize important points from Lectures and reading. Summarize management activities that are being developed for the team projects (team report).
4	Leadership & Team Work in Engineering Systems	Read Week 4 lecture notes. Read **"How to Choose a Leadership Pattern," "Change The Way You Persuade," The Seven Ages of the Leader,"** and **"Thumbs Up for Self-Managed Teams."** Summarize important points from Lectures and reading. Summarize team work and leadership activities that are being developed for the team projects (team report).
5	Failures of Engineered Systems and the Standard of Care	Read Week 5 lecture notes. Read excerpts from ***Lethal Arrogance*, "Failures of Engineered Systems",** and **"The Concept of Care in Engineering".** Summarize important points from Lectures and reading. Summarize how the concepts of care in engineering and prevention of failures of engineered systems are being incorporated into the team projects (team report).
6	Engineered Systems and System Analyses	Read Week 6 lecture notes. Read excerpts from ***Schools That Learn*** and ***The Fifth Discipline Field Book***. Summarize important points from Lectures and reading. Summarize system components associated with team projects and perform analysis of one critical function (team report).
7	**Team Projects**	**Report and presentation by each team summarizing the goals, objectives, organization, planning, and status of their projects. Summary report due end 7th week** (Thursday start of class).
8, 9	Life-Cycle System Engineering	Read Weeks 8 and 9 lecture notes. Summarize important points from Lectures. Summarize the life-cycle system engineering associated with team projects (team report). **Spring recess follows Week 9 (March 24-28).**
10,	Quality & Reliability	Read Week 10 lecture notes. Read **" Quality and Reliability of Engineered Systems."** Summarize important points from Lectures. Summarize quality and reliability attributes that have been incorporated into the team projects (team report).
11, 12	Engineering systems, Reliability Based Criteria	Read Weeks 11 and 12 lecture notes. Read **"Engineering Systems: Reliability Based Criteria".** Summarize important points from Lectures and reading. Summarize analyses of system components associated with team projects (team report). **Undergraduate Research Opportunity Poster Session for Projects.**
13	Trade-offs, Economics, and Decision Analyses	Read Week 13 lecture notes. Read **"Target Reliabilities for Engineered Systems".** Read excerpts from ***Trade-Offs*.** Summarize important points from Lectures and reading. Summarize analysis of alternatives and trade-offs associated with team projects (team report).
14, 15	Approaches & Strategies to Achieve Adequate Quality & Reliability	Read Weeks 14 and 15 lecture notes. Read **"Engineering Systems to Achieve Quality and Reliability."** Summarize important points from Lectures. Summarize the approaches and strategies to achieve quality and reliability associated with team projects (team report). **Final project technical paper, Project Notebook, and Course Notebooks due Thursday, May 8th start of class. Complete course evaluation forms**
16	**Presentation of Term Projects**	**Formal presentations of term projects, posters, and a demonstration model of the system, Wednesday, May 14th, Sibley Auditorium, 8:00 am (set up), 8:30 am poster & model showing, 9:00 am presentations, 12:00 n conclude. Presentation rehearsals scheduled for Monday, May 12th, Sibley Auditorium, 3:30 pm to 5:00 pm.**

Suggested readings

The Engineer of 2020, Visions of Engineering in the New Century, National Academy of Engineering, The National Academy of Engineering Press, 2003.

Civil Engineering Body of Knowledge for the 21st Century, Preparing the Civil Engineer for the Future, American Society of Civil Engineers (ASCE), January, 2004.

Managing and Leading, S. Walesh, ASCE Press, 2004.

It's Your Ship, Management Techniques from the Best Damn Ship in the Navy, D.M. Abrashoff, Warner Books, 2002.

Conceptual Blockbusting, A Guide to Better Ideas, J. L. Adams, W.W. Norton & Co, 1979.

The Fifth Discipline Fieldbook, P. Senge, A. Koleiner, C. Roberts, R. B. Ross, B. Smith, Doubleday, 1994.

Tradeoffs, Imperatives of Choice in a High-Tech World, E. Wenk, Jr., The John Hopkins University Press, 1989.

Making Hard Decisions, R. T. Clemen, 1996.

Lethal Arrogance, Human Fallibility and Dangerous Technologies, L. J. Dumans, St. Martins Press, 1999.

Course student grading assessments

The following is the basis that will be used to assess and grade student course deliverables:

letter grade	numerical grade	grade worth	description
A+	**98 - 100**	**4.0**	**Outstanding**
A	**95 – 97.9**	**4.0**	**Excellent**
A-	**90 - 94.9**	**3.7**	**Great**
B+	**85 - 89.9**	**3.3**	**Very Good**
B	**80 - 84.9**	**3.0**	**Good**
B-	**75 - 79.9**	**2.7**	**Not so Good**
C+	**70 – 74.9**	**2.3**	**Very Fair**
C	**65 – 69.9**	**2.0**	**Fair**
C-	**60 – 64.9**	**1.7**	**Not so Fair**

The following is the basis that will be used for evaluation of deliverables gradings (including the final project technical paper):

Category	Grade	Comment
Background		**(extent of scholarship developed)**
Application		**(use of background and course materials)**
Analyses		**(assessments of background as applied to engineering systems)**
Understanding		**(depth of insights developed, extent of assessments of system components and their interactions**
Documentation		**(professionalism, clarity, completeness, conciseness, format)**
Total		**(equal weighting of foregoing)**
Overall Evaluation		

Each of the categories shown above will be graded equally (20 points each) to determine the grades. Students will receive copies of the resultant grading forms (so students know what can be improved or maintained).

The course instructors know that you have worked really hard to get where you are and that you are very capable and highly qualified to excel in this course. Thus, as you start the course, you have an A+ grade! We want all of you to maintain the A+ grade and do not want your performance to indicate otherwise. In this course, students will work both individually and as members of Term Project teams. Team performance will be evaluated in addition to individual performance.

A good course experience results from both the student and the instructors efforts. These components are highly interactive, inter-related, and interdependent (the characteristics of a system). We will need your help to make this a really great - the best - course experience possible. **Please be forthcoming and generous with that help.**

This is a very demanding course and we are equally demanding of excellent performance - for students both as individuals and as members of project teams. As well, we are demanding of excellent performance on our parts. You will need to mobilize - use - apply most of what you have learned to this point in your education and experience. And, you will need to develop and use several new things that will include both traditional engineering topics and be far beyond these topics. This is the essence of a 'capstone course' in engineering.

If you are not highly motivated to learn and to work in a very demanding course that is going to take you into some familiar and some unfamiliar areas, then this is probably not the course for you. If you want to learn some new things, use some old things, excel in these activities, and develop some knowledge, skills, and contacts that have **VERY HIGH CAREER VALUE**, then this is the course for you!

Course student deliverables

The final course grade will be computed based on the grade from class preparation and participation, course notebook, and homework - field trip assignments (Deliverable #1 = 30%; each part 10%), and from the intermediate report and presentation (with draft URO poster), final project paper, notebook, model, and presentation (with final poster) (Deliverable #2 = 70%, two project reports 30% of the Deliverable #2 grade and each other part 10%).

There will be no mid-term course examination. There will be no final course examination.

There will be a mid-term presentation of the team projects; this presentation and an associated summary report and participation in the Undergraduate Research Opportunity Poster Session will be graded and incorporated as part of the Deliverable #2 grading.

In this course, students are strongly encouraged to focus primarily on developing a quality learning and application experience that can help careers and lives. We strive to make the course assessments and grades reflect the quality of the student's demonstrated diligence, effort, and accomplishments in learning and applying the elements of this course.

Deliverable #1 – Class preparation and participation, individual homework assignments, and course notebook

There will be three components to Deliverable #1:

1) **Class preparation and participation**
2) **Discussion section assignments (team project status summary reports), and**
3) **Course notebook (includes homework assignments summarizing lectures and readings, special publications, discussion section notes).**

Each of these components will be graded at 10% of the final grade. The class preparation and participation and the course notebook will be graded on an individual basis..

Homework assignments: a part of the homework assignments (summarizing the week's lecture notes, discussion section notes, and assigned reading) are to be performed by each class member. These weekly individual assignments will form an important part of the student course notebooks.

Another part of the homework assignments should be developed by the student project teams (team project status summary reports - to be detailed later). This allows students to share background, insights, capabilities, and talents in developing very high quality assignments. This is an important element of class ‘team work’. This allows students to become part of the instruction and learning process of their classmates. This part of the work is important in developing individual knowledge, skills and rules about how to solve problems and document the results.

As per the grading guidelines high scores will be given for organization, clarity, precision, and professionalism in documentation of homework assignments.

One of the homework assignments is for the student teams to organize, conduct, and document a field trip to an engineering operations - construction site of their choice during the semester. Desirably this field trip would be associated with the student team project. The timing and

conduct of the field trip is left entirely up to each of the project teams. The documentation of the field trip is to be incorporated into each student's course notebook. This documentation can be prepared by each team member or one developed for each member of the team by the project team.

In performing team assignments it is very important that all of the members of the team participate on an 'equal' basis - sharing the work so that all can participate and contribute. **Say what you will do and do what you say you will do. Teamwork evaluations will be part of the grading assessments.** These assessments will be developed by the members of the team and by the course instructors.

Preparation & Participation: another important part of the evaluation of Deliverable #1 is based on class preparation and participation. Copies of the assigned readings are incorporated in Part 1 of the course reader. Additional reading sources have been cited earlier in this syllabus.

The first most important part of this participation is to thoroughly **prepare (read, discuss) and do independent background work before class. Take good notes during your reading, background work, and during lectures (this task can be shared among the members of a project team). Part 2 of the course reader contains a copy of each of the graphics that will be shown during the lectures. The reader has been printed on one side so that you can take notes on the back side of the page preceding the page with the lecture graphics.** Many important elements will be developed in class that are not detailed in the course reader. It is important that you capture these elements in your class notes. A weekly assignment will be to summarize in documents to be included in your course notebooks the content of the lectures as they apply to development of the team projects. Do not include pages from the Part 2 course reader.

Come prepared to class with your ‘grocery list’ of things you want to listen for during the lectures. The reader will give you the outline of what is to be presented - discussed. Generally, we will start classes and discussion sections with a question: Has anybody got special discussion topics or questions? Here is the first opening for your participation. We want and value your verbal – vocal – intellectual interaction during class. Be as concise and clear as possible in posing your questions or introducing your discussion topics before and during the lectures / classes. Your verbal interaction during class is the only way that we can tell how effectively we are transmitting the course materials to you. Avoid diversions from the topic or subject. But, speak-up when you do not understand or need more information - communication!

We know class oral participation and interaction is really difficult for ‘non-native’ English speakers. We have nothing but the greatest respect for non-native English speakers for their linguistic capabilities and abilities to understand another national culture. It is very important for non-native English speaking class members to express themselves in class. It is critical to our learning experience. You will be given full permission to make mistakes and be unable to ‘find the right word.’ All of us will try to help. One of the critical objectives is to learn how to communicate through the medium of the English language. We will need your help.

Course Notebook: at the end of the course (beginning last class) each individual class member will be required to turn in a course notebook. **Develop an <u>individual</u> course notebook** that will contain your summaries of readings, lecture - class notes summaries, background development (e.g. web searches, interview notes), individual homework assignments, special handouts, copies of publications that you want to keep, a log of project and course activities, and notes and pictures from field trips. **You should not include copies of information from the course reader; do not include your course readers or pages from the course readers**. Your course notebook should be **your**

personal archive for all of the non-course readers materials that you want to include in your professional library (if you have not started such a library, you should start one now!). The quality and completeness of the documentation included in the course notebook will determine this portion of your final grade.

Deliverable #2 – Term Team Project

There will be four components to the Term Project Deliverable #2:

1) **Project technical paper,**
2) **Project notebook,**
3) **Project model/s,**
4) **Project oral presentation (including demonstration poster), and**
5) **Mid-Term project team report and presentation (including Undergraduate Research Opportunity Poster Session)**

Each of these components will be graded at 14% of the final grade. All members of a team will receive the same grade for each of the components of the Term Team Project.

The term project is of particular importance; this is the reason that it is weighted at 70% of the final grade. The term project provides an opportunity for you and your project team to learn more about a special topic that applies to this course (knowledge), and perform analyses and develop insight and understanding (application of knowledge = skills). Many of the past term projects have been published or formed the basis for special project reports, theses, and dissertations. Several of the term projects have received national and international media attention and awards.

During the first two weeks, the class will be formed by the course instructors into teams of 3 (minimum) to 5 (maximum) enrolled class members. We will spend the first week of lectures (2) and discussion section developing background on class projects (how to define good topics, goals, objectives). We will spend the second week of lectures (2) and discussion section developing background on formation of class teams. These are two very important learning experiences for the class.

Term projects are selected, defined, and developed by class teams whose members are students enrolled in this class. Selection of the term project topic is left completely up to the teams **with the requirement that it address topics and elements that are of importance in Engineering Systems and achieving acceptable quality and reliability of these systems during their life-cycle**. We will be happy to assist the class in definition of potential project topics.

You will learn during the first weeks of class how we define each of these key words: engineered systems, engineering systems, quality, reliability, acceptable, life-cycle. Consult the reader for these definitions as early as possible. The selection of the term project topic is left up to the student teams to provide the student teams with the freedom and responsibility associated with selection of a topic of interest to them and of potential importance in the development of their professional knowledge and skills. We are available to help student teams identify a good project topic and identify a viable scope for that project.

The following is a list of topics of some of the projects from recent classes:

Past successful CE180 project topics	
Development of rebuilding guidelines for homes in the Lakeview area of New Orleans	Development of fresh water supply systems for a coastal village in Chile
Assessment of the potential for levee failures in the Sacramento Delta area	Design of an effective roadside automobile barrier system
Golden Gate Bridge Suicide Barrier	Rehabilitation of the UC Bear's Stadium West Wall
Development of a Delta wetland system	Gas supply earthquake emergency shut-in system
An aerial transportation system for connecting Oakland with Alameda	Decommissioning a dry dock in the Port of San Francisco (2003 winning project)
Engineering a ski train system for Colorado	BART tunnel seismic retrofit system
An underway tunnel freeway system for downtown San Francisco	A freshwater production facility for third world country communities
A seismic rehabilitation system for the foundations of the San Francisco Bay Bridge	A deepwater tension-leg drilling and production system for offshore Venezuela
An offshore oil and gas drilling and production platform system for Vietnam	A container ship port system for Oman
A seismic rehabilitation system for the Oakland Public Library	A breakwater for a port in St Lucia
Engineering a suicide barrier for the Golden Gate Bridge (received local TV and national CNN news time, received national award)	Assessment of alternatives for the continued use of the 1927 Carquinez Bridge (project continued in 3 classes)
Assessment of alternatives for a floating runway extension to San Francisco International airport	A float-over deck concept for offshore Spar production platforms (2002 winning project, 2nd place in international design competition)
Surfing and beach erosion prevention system in Pacifica (2001 winning project)	A process to assess the adequacy of dikes in the delta of the Sacramento River
Remediation of a hydrocarbon polluted site in San Francisco	Re-useable - adaptable floating offshore production system
Center divider for the Golden Gate Bridge	Alternatives for decommissioning platforms offshore California
Rehabilitation of U.S. Navy waterfront facilities	Rehabilitation of the Alviso marina in San Francisco Bay

As you can tell, previous projects have included all of the major emphasis areas within Civil & Environmental Engineering (transportation, environmental, structural, geotechnical, construction, engineering & project management, systems engineering) and also Ocean Engineering. Most of the projects involved **several** of these emphasis areas and also knowledge areas outside of engineering (e.g. management, political - social science, business, economics, law, history, art, architecture). This is the nature of **engineered systems**.

A second important part of the term project is development of the project teams. A critical ingredient in these teams is 'requisite variety' in the members of the team - the variety of backgrounds, interests, motivations, knowledge, skills, and capabilities of the members of the team should match the variety of tasks and technologies contained in the chosen team project. But, there is much more to the development of effective and efficient teams - including such things as cooperation, leadership, followership, motivation, planning, organizing, controlling. This is an extremely important part of the class experience. This may be a radical departure from most of your previous University learning experiences. But, this is the reality of being an engineer - developing effective teams that will produce projects on time, on budget, and with happy customers (three rules of engineering).

Full cooperation of the team members is critical. Equal sharing of the work is equally important. If a team member is not cooperating or motivated or unwilling to do their share of the

work, then that team member should be asked to leave the team (we will be glad to help as necessary), and if done early enough, seek membership in another team, or drop the course. **The student drives to cooperate and share come from self-motivation and integrity.** If a potential team member does not possess that motivation and integrity, there is no reasonable way that it can be enforced or forced.

Another important part of the project teams are the project consultants and advisors. These consultants and advisors need to have expertise in the project topic. **These consultants and advisors must have motivation to help the student teams.** These consultants and advisors are a primary source of information to both define and develop the projects. These consultants are identified by the project team members (and again, we are happy to help). These consultants and advisors will grade the project report, model, and presentation of the team they worked with. In addition, they will grade the models and presentations of the other teams. **It is very important that the consultants and advisors (or a qualified representative) be present at the project presentations held during the 16th week.**

The foregoing indicates that the selection of project topics and project teams is highly interactive and recursive. A project topic or idea is only viable if all of the ingredients can be brought together: A good topic, a good team, and a good group of advisors and consultants. We will discuss good topics during the first week of class. We will discuss the backgrounds, capabilities and motivations of the class members during the second week of class. Within the backgrounds of the class members should be 'contacts' with potential advisors and consultants that can help address good project topics. These contacts need to be developed as quickly as possible because they will be very important in helping define or refine good project ideas. If the advisors and consultants perceive that the project topics and ideas are important to them and their organizations, then cooperation and help should follow. If the topics or ideas are not sound, then the advisors and consultants probably will not be effective.

The experiences with past teams and projects indicates that in many cases the project teams do not effectively access or utilize the project consultants and advisors. There are many reasons for this ineffectiveness; everybody is busy; it is tempting to procrastinate; it is not easy to set up, conduct, and develop the needed information from project team - consultant / advisor meetings. But, learning how to effectively develop and use valuable sources of help and information is another important part of the course learning experience.

We also noted the recursive nature of the project ideas - topics. The ideas and topics may be modified as the projects are developed - this is to be expected. As more knowledge and information are developed, then the focus and engineering processes must change so that the key objectives of the project and team experience can be developed - to do something that is of high quality and potentially important - and to learn how engineers and engineering teams work (or don't work!). But, this also indicates that it is important to earnestly start the projects very early so that radical shifts in the project focus late in the semester can be avoided.

Of particular importance is to identify project topics and scopes that will allow **sufficient depth** in their development. **The projects should be developed in the context of a 'feasibility study' - the depth should be such as to demonstrate the viability or non-viability of a particular engineered system - or option for engineering such a system.** Very broad and superficial project topics and scopes should be avoided. Projects without clearly defined goals and objectives should be avoided. It is of critical importance at the outset to clearly define the goals and objectives of the project – what you want to ‘find out’ – to ‘show’ – or ‘to learn and apply’. Proper focus is critical to help minimize inefficient use of resources.

A key resource in the term projects is **TIME. This is a challenge for development and application of the student's ENGINEERING PROJECT MANAGEMENT knowledge and skills.** Use this resource wisely. Start early and fast. Finish early and slowly. **Avoid procrastination and wishful thinking.**

This course has a credit value of 4 units. Four units of capstone course work are expected to take about 5 hours per unit per week (per student, moderate pace). **This equates to about 20 hours of student effective effort per week devoted to this course.** Given that 30% of the course grade is dependent on Deliverable #1, about 6 hours per week should be spent on class preparations and participation, homework assignments, and the documentation leading to the course notebook. Given that 70% of the course grade is dependent on Deliverable #2, about 14 hours per week should be spent on the team project efforts including the intermediate report and presentation (and URO poster and presentation), project technical paper, notebook, model, presentation, and team project meetings. **Each student should plan and schedule time during each week to assure that these time and efforts are realized.**

Funding for the projects, project materials, and even project team travel can be and have been obtained from a variety of University and non-University sources. The course instructors can help identify some of the sources for this funding. **This funding process is left to the imagination and initiative each of the project teams.** One of the funding sources available in the past has been the Undergraduate Research Opportunity (URO) program. Funds are provided by this program to assist the student teams. In return for this support, the student project teams are required to develop and present a summary poster that addresses their project (scheduled for Wednesday April 13). Guidelines and assistance are provided by URO for development of the posters (see the URO web site for details). Funds also have been provided by companies supporting or sponsoring the student projects.

Project Technical Paper: The project teams can determine what needs to be included in the final project technical paper by reviewing the grading form that was provided earlier. The attributes that are graded include **background** (documentation of research and information development results), **application** (of the information and background developed during this course), **analyses** (evaluations and assessments of background and application, **understanding** (reflecting important insights approaches, strategies to positively influence quality and reliability), and **documentation** (clarity, organization, professionalism, completeness, accuracy, references, tables, graphics). It should be obvious that development of such a report requires a significant amount of time and can not be done 'right' the first time. Multiple drafts and revisions are required to develop a polished finished product that you will be proud to have reviewed. The technical paper should be documented according to the American Society of Civil Engineers **technical paper journal published** format (not draft! see published ASCE papers to serve as guides, paper format guidelines available on ASCE web site - publications - authors). This paper will be graded by the instructor, the graduate student instructor, and by the project team advisors - consultants (consensus grade). **The project technical paper is due at the end of the 15th week of class. This will give the teaching team and consultants / advisors sufficient time to review and evaluate the final project technical paper before the team project presentations and evaluations during the 16th week of class (scheduled for Wednesday May 14th in the Sibley Auditorium).**

The project technical paper should be supplied to the team coaches / advisors prior to the 15th week (one week including a weekend minimum) so that the team coaches / advisors can review the paper, and return it to the team in time for the team to be able to revise the paper to take advantage of the review comments provided by the coaches / advisors. It is up to each of the teams to make the necessary arrangements with the project coaches / advisors to review and return the project technical paper.

Project Notebook: The project notebook should contain all of the back-up materials developed for the project including project communication documentation, discussion summaries, technical papers, calculations, drawings, pictures (from field trips). **The project notebook is due at the end of the 15th week of class.** The project notebook will be graded by the instructor and the graduate student instructor. We will be glad to review each of the team's project notebooks at the mid-point of the semester to help the teams assess their progress, identify critical challenges, and develop approaches to enable successful completion of the projects.

Project Model & Poster: The project physical model and associated explanatory poster needs to be ones that can clearly show the important aspects of the engineering system that has been addressed. **The models and posters will be displayed outside the Sibley Auditorium before the formal presentations on the day of the project presentations.** The project teams are responsible for all of the facilities that are needed for the model and poster displays. Posters should explain important developments and details about the project and model. As possible, the models, or components of the models should be used in the project presentations. The models will be graded by the instructor, the graduate student instructor, and the team consultants - advisors (a consensus grade for each team). There are University facilities and personnel that can help with the model building - assembly process and these need to be mobilized as early as possible. Acquisition of the model and poster materials is the responsibility of the project teams.

Project Presentation: The project presentation is scheduled during the 16th week before the final examination period. The presentation will be held in the Sibley Auditorium between 8:00 and 12:30. The instructors will make arrangements for the auditorium. **All other arrangements for the presentations (e.g. single computer with assembled presentations, AV equipment) and model showings are the responsibility of the student teams**. With sufficient advance notice from the student teams (2 weeks), the course instructors can assist the project teams in securing parking for the consultants and advisors that attend the presentations. The project models are presented - demonstrated during the period 8:00 to 8:30 on tables outside of the auditorium (models are mobilized to the auditorium before 8:00). Each of the project presentations is given approximately 15 minutes (strict control of the time) with 5 minutes for questions and answers. The project teams are encouraged to arrange for presentation rehearsals. Arrangements for these rehearsals and presentation equipment (e.g. computers and computer projector) is the responsibility of the project teams. The project oral presentations will be graded by the instructor, the graduate student instructor, and the team consultants - advisors (a consensus grade for each team).

It is important that each of the teams make arrangements early in the semester with the project coaches / advisors to attend the project presentations. If a coach / advisor is not able to attend, they can designate a delegate to attend the presentation; it will be important that the delegate be very familiar with the project developments**. At the conclusion of the presentations, the project coaches / advisors will grade the technical paper for the project that they coached / advised. The project coaches / advisors also will grade all of the other presentations, models and posters.** During the project evaluations that will be made following the team presentations, it is important that the

coaches / advisors from each of the teams be able to discuss among themselves and with the coaches / advisors of other teams the project developments and assessments.

Project Awards: After the completion of the project presentations, based on the gradings of the four team project deliverables, cash awards will be made to each member of the winning team ($100 each). The runner-up team will receive a cash award from the Undergraduate Research Opportunity program ($250). Generally, there are representatives from University and other media organizations that will be present and want to have written information, interviews, and pictures of the teams and project models.

Project Mid-Term Report, Presentation, and Poster: During the 7th week of classes, the project teams will submit a mid-term report on their project that summarizes the goals, objectives, and developments in the projects including identification of the project consultants, their roles, and their affiliations. **Each of the project teams will present a summary of their projects and developments during the 7th week of classes. The mid-term project report is due at the end of the 7th week of classes (Thursday beginning of class).** A summary of these projects will be developed by each team and documented on a poster suitable for presentation. **Participation by each team in the Undergraduate Research Opportunity poster session is a part of this requirement. Guidelines and assistance will be provided for development of the posters.**

The project teams should schedule weekly meetings so that all of the members of the team can be present. A different member of the team should lead each of the weekly team meetings and another member of the team should take responsibility for summarizing the results from the meeting. **The purpose of these weekly team meetings is to for students to learn how to SELF-MANAGE the team project including PLANNING, ORGANIZING, LEADING, and CONTROLLING.** The team consultants / advisors can be invited to attend these meeting as appropriate.

It is a course requirement that the results from the weekly team meetings be documented in a team project status report and turned in at the beginning of each week (first summary due beginning week 3 documenting the week 2 developments). This team project status report should include the week's goals and accomplishments, shortcomings and actions taken to address them, and an assessment of team performance. Once everyone in the team has had a chance to lead a meeting, the team may either elect a permanent group leader/s or continue to rotate the position throughout the membership. The final project status report (due beginning week 15) should summarizes the challenges your team overcame, the most difficult part of the project, what your group would do differently on the next project, what was the most rewarding part of the project, what did your team learn about operating in a team environment, and recommendations for improvements in the course project for the next class.

Key Reasons for team and project SUCCESS

During the past 16 years, approximately 60 student team projects have been developed as part of this course. Many of these projects have been very 'successful' in that they clearly met the majority of important expectations of: 1) project team members, 2) course instructors, 3) project team consultants and advisors, and 4) other faculty, students, and staff associated with this course. Several of these projects have won national and international awards. Several projects have had summaries of the projects published in technical journals. Several of the students participating in these projects have transitioned directly from the course project to jobs with the companies that provided consultants and advisors for their projects.

This experience has given some important insights into the reasons for project success:

1) important and appropriate project focus - topic: engineering systems
2) capable, cohesive, and committed student team (teamwork and leadership)
3) capable, supportive student team consultants - advisors
4) well managed (planning, organizing, leading, controlling) student team
5) very effective utilization of time (early start) and other project resources
6) clear understanding of clients (instructors, consultants) expectations and content of deliverables
7) in-depth engineering and engineering systems project content
8) professional presentation of the project results including oral summary, project technical report, project notebook, and project model with poster (used effectively in the summary)

The most prevalent reasons for less than desirable project success have been inappropriate use of resources (lack of good planning, managing, organizing, and controlling; procrastination and wishful thinking are real enemies!), inappropriate selection of and / or use of project advisors, inappropriate project focus and / or scope, and dysfunctional student teams.

Course assistance

There are many sources of student assistance in developing an adequate understanding and mastery of the course materials: 1) previous graduates of the course and students from other allied courses, 2) other faculty members (inside and outside the College of Engineering with knowledge and experience in the course materials), 3) knowledgeable and experienced practitioners - engineers - and managers, 4) additional reading and reference work (including use of the WWW and the library), and 5) the course instructors**. Students are encouraged to use all of these sources of assistance.**

I have scheduled - by appointment - meetings with students (and student teams) in my office in 212 McLaughlin Hall (see door schedule). You can sign up for an appointment on the sign-up forms kept outside of 212 McLaughlin Hall on a clipboard that is kept to the left of the door.

If you can not attend your scheduled appointment, please remove your name from the schedule as soon as possible so that other students can have access to the time. **Please make a note of your appointment so that you do not forget the appointment**. Our time is limited and we want to make the best possible use of that valuable resource.

When you schedule a meeting, please come prepared for the meeting with well organized questions, requests and discussion points. If you need to have me do background work to respond to your questions and requests, please let me know as early as possible - in writing if possible - so that I can have time to do the background work.

Given that there is sufficient enrollment in this course, there will be a course Graduate Student Instructor (GSI). The GSI for this course also will schedule hours to meet with students. The location and schedule of days and times for these meetings will be announced at the beginning of the semester and posted on the course web site.

If it is really important, and you can not get a slot for a scheduled meeting or walk-in meeting, then let us know so that we can schedule a meeting with you or the project teams. We need a minimum of 24 hours notice to get such meetings arranged.

One of the primary functions of the Discussion Section of this course is to address team questions and issues that will be of general interest to the entire class. We will schedule time for such discussions. Please plan and organize these discussions - and give us as much notice as possible so that time can be allocated during the discussion Section.

Often, I can respond to 'limited' student questions and requests via e-mail (bea@ce.berkeley.edu). Use this form of communication and course assistance carefully. I will respond as soon and as completely as I am able - generally within 24 hours.

A very 'rich' course web site has been developed to help facilitate distribution of course developments, materials, and communications (https://bspace.berkeley.edu/). New course announcements will be posted each week during the semester. **You should periodically consult this web site during each week for the latest developments and announcements.** This web site can be a valuable part of a communication network.

Another avenue for course assistance is for students to organize special help or discussion sessions out of normal class hours to address specific course topics. We are glad to attend such sessions and assist with the discussions. However, we must be able to schedule these sessions in our normal schedules; and this will take planning. Securing a class room for these sessions and making arrangements with and for those that want to attend the sessions is left to the students (e.g. notices of time and place, copies of handouts).

A very useful source of course assistance is for you to give us advice during the semester on how to make the course more effective for you - and your classmates. We have received and implemented many suggestions that have been developed by the students in previous classes. The course that you will experience represents a continuous process of updating and hopefully improvements, many of which came from previous students. Important aspects of these suggestions are their 'practicality' (= they can be implemented within the existing constraints in this course) and their 'effectiveness' (= they can result in substantial improvements). Our meetings are generally a very good time for you to discuss these suggestions.

At the end of the semester, you will have the opportunity to grade the worth of this course and our performance as a Course Instructor and Graduate Student Instructor. We strive for the highest possible grades - just as you do - in this course. We want this course to be one of the most important and best courses that you have ever taken. **Please let us know if the course or our quality of instruction is not at these levels - and what we can do to bring these elements to these levels (practical and effective). We expect the same fairness and treatment that you do. The rest is up to us**.

Course discussion section

The objectives of the discussion sections are to:

1) Reinforce and clarify the material presented in lecture through informal discussions, examples, assignments, and field trips.
2) Advise teams in building, developing, and successfully completing course projects

ASSIGNMENTS - Assignments are due at the beginning of class on the date noted. Each graded assignment will be returned at the beginning of each discussion section.

Schedule of course discussion section assignments

Week	Module	Content
1	Introduction	Document background on a project topic you are interested in (2 page, single spaced summary) and be prepared to discuss this topic. Due Monday January 23.
2	Term Projects and Project Team Developments	Form into teams of 4 to 5 students; define project title, goal, summary abstract; and develop list of project consultants. Document results (project title, goal, abstract; list of team member names and contact information, list of project consultant names and affiliations). Due Monday January 30.
3	Leadership and Management in Engineering Systems	Team project status report 1 (week 2 developments).
4	Leadership & Team Work in Engineering Systems	Team project status report 2 (week 3 developments).
5	Failures of Engineered Systems and the Standard of Care in Engineering	Team project status report 3 (week 4 developments)
6	Engineered Systems and System Analyses	Team project status report 4 (week 5 developments). Prepare team project summary presentation.
7	**Team Projects**	Team project status report 5 (week 6 developments). **Team project summaries presented in class.**
8	Life-Cycle System Engineering	Team project status report 6 (week 7 developments).
9	Life-Cycle System Engineering	Team project status report 7 (week 8 developments).
10	Objectives: Quality & Reliability	Team project status report 8 (week 9 developments). Prepare URO poster for project.
	Spring Break	**March 23 - 27**
11	Engineering & Analyzing Systems: Reliability Based Criteria	Team project status report 9 (week 10 developments). **Undergraduate Research Opportunity poster session for projects.**
12	Trade-offs, Economics, and Decision Analyses	Team project status report 10 (week 11 developments).
13	Trade-offs, Economics, and Decision Analyses	Team project status report 11 (week 12 developments).
14	Approaches & Strategies to Achieve Adequate Quality & Reliability	Team project status report 12 (week 13 developments).
15	Approaches & Strategies to Achieve Adequate Quality & Reliability	Team project status report 13 (week 14 developments).
16	**Presentation of Projects**	**Formal presentation of term project results including the project paper and a demonstration physical model of the system**

Have a great semester in learning (knowledge) and applying (skills) to Engineer Systems. You will be the Engineers of the 21st Century - advancing CIVILIZATION & ENVIRONMENTAL ENGINEERING to new achievements for the societies that we serve.

Bob Bea